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CALIFORNIA UNIV LOS ANGELES

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STUDY OF AGE EFFECTS ON TASTE-SMELL INTERACTIONS WITH BLENDED F--ETC

JUN 80 C MURPHY

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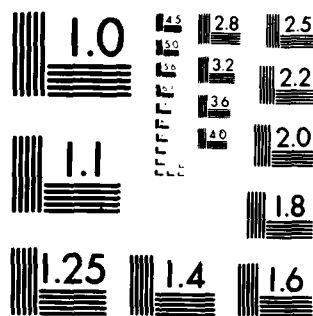
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*(9)* Final Report.

Study of Age Effects on Taste-Smell Interactions with Blended Foods,

*(10)* Claire/Murphy

University of California,  
Los Angeles

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## Experiment 1

Recently Schiffman (1977 and in press) has adapted a technique previously used chiefly in clinical research for evaluating the anosmic's difficulty in appreciating food flavor (Mozell et al., 1969; Clark and Dodge, 1955a, 1955b; Crosland, Goodman and Hockett, 1926). She has compared the ability of the elderly and the young to identify blended foods. The blindfolded observers were allowed to smell and then taste the blended foods before producing an identification. The young subjects were significantly better at recognizing most foods, although the elderly did better with certain items (e.g., potato and tomato), and equally well with others (sucrose and NaCl). These studies were the first in the modern literature to demonstrate empirically these deficits in identification experienced by the elderly, and they prompt the question: Do these difficulties in recognizing blended foods actually reflect deficits in the chemical senses in the elderly which may underlie nutritional problems in the geriatric population?

How a failure to recognize blended foods contributes to nutritional difficulties in the elderly may not be obvious. One might expect that a person would probably eat food which tastes good regardless of whether he can identify it. The issue becomes clearer if considered in the context of menu planning and ingestion. Expectation about taste quality influences the pleasantness of a subsequent sensory impression (Moskowitz, 1978). For example, when applesauce is so bland-tasting to an elderly person as to be mistaken for mashed potatoes, then, if he receives applesauce for dessert, he may not be inclined to eat it. For the person for whom identification is difficult because all stimuli taste like mashed potatoes, lack of variety could make eating more of a chore than a delight. Moskowitz (1978) has pointed out that degree of liking and the frequency with which a person wishes to eat a particular food item are not equal. For example, Peryam and Pilgrim (1957) reported that although mashed potatoes and white bread were of approximately equal preference, subjects in their study were willing to eat white bread twice as often as mashed potatoes. Many food items which were highly preferred (e.g., lobster newberg) could not be tolerated several times daily. There is also a potential problem in preparing food which will taste good to the elderly person, aside from his ability to identify it. Intensity is a potent predictor of hedonics (Moskowitz et al, 1976). If the elderly person's perception of a food is altered because he tastes and smells the actual intensity of only a subset of the tastes and/or odors present in a food item, then not only will he have difficulty identifying the food, but he may also find the taste unpleasant. Pinpointing any sensory causes of this potential problem (taste, olfactory or trigeminal) may suggest possible ways to enhance flavor and hence, palatability.

Early work on olfactory identification had generally supported the hypothesis that typical subjects could learn to identify only a small number of odors: about sixteen to eighteen (Engen and Pfaffmann, 1960; Jones, 1968; Mozell et al, 1969; Engen and Ross, 1973; Lawless and Cain, 1975). Jones (1968) was, however, able to demonstrate the ability of two perfumers to recognize 150 and 164 of 192 odors when they were presented the odorants in 12 series of 16, and given a list of the 16 correct responses with each series. Supplying stimuli which were rich in information content, Deser and Beauchamp (1974) were able to demonstrate the ability of subjects with "non-professional noses" to identify as many as 60 of 64 odors. Most recently, Cain (1979) has demonstrated the ability of subjects to identify on the average 94%, though for some subjects 100%, of a library of 80 odors when given practice and feedback in assigning veridical labels to those odors. Davis' (1975) experiment showing that subjects learn an association between numerals and familiar odors more rapidly than between numerals and unfamiliar odors provides further evidence for the significance of cognitive factors in identification of

stimuli within the chemical senses. Clearly, cognitive factors play a significant role in the ability to identify chemosensory stimuli. That age can affect cognitive functioning is well documented (Goldfarb, 1975; Davies, 1968; Pollack, 1965; Inglis, 1965). The following experiments are designed to manipulate the influence of cognitive factors in the assessment of the abilities of elderly persons and college students to identify blended foods. Since this experiment employs Schiffman's method, the data generated in the first session for each subject will also serve as an attempt at replication. In addition, data from smokers will be compared with data from non-smokers, and data from males compared to data from females.

### Method

Subjects in the experiment were 34 persons 18-26 years of age and 27 persons 65 or more years. All were ambulatory, non-institutionalized persons who had not been hospitalized within the preceding 12 months. Young subjects were recruited from the UCLA campus. Elderly subjects were recruited from the Senior Citizens' Center of West Los Angeles, the area surrounding the UCLA campus, and from those elderly persons who had served in psychoacoustic studies at UCLA. Ratios of males to females and of smokers to non-smokers were approximately equivalent in the two groups. All subjects were paid for their participation.

Stimuli were the following: potato, tomato, carrot broccoli, celery, lemon, pear, banana, beef, coffee, sugar and salt. The vegetables and fruits were steamed and then blended to a smooth consistency. The beef was baked in foil with bones and fat removed and then blended. Coffee, lemon, sugar and salt were each combined with a mixture of cornstarch and water thickened over heat to a smooth consistency. All stimuli were maintained at a constant temperature until being presented to the subject. All stimuli were freshly prepared on the day of each experimental session.

Procedure The subject participated in one identification session with no feedback as to the correctness of his responses and as many sessions with feedback as were necessary for him to correctly identify all twelve stimuli, or ten sessions, whichever occurred sooner. Sessions were approximately one half hour in length. The first feedback session was run immediately after the no-feedback session. Subsequent sessions were run at 2-5 day intervals thereafter.

With the exception of feedback, which consisted of the subject being informed that he had been correct or incorrect and the correct identification when he had been incorrect, the sessions were identical. All sessions were run with the subject blindfolded and seated at a table. The subject was told that he would be asked to identify a series of foods which had been either blended or combined with a mixture of cornstarch and water to minimize texture clues. The experimenter then placed a plastic spoon with a teaspoonful of the stimulus under the subject's nostrils with the instruction "sniff." After the subject had had an opportunity to sniff the stimulus he was instructed to taste, and the food was placed in his mouth. He tasted the food, maximizing exposure to the oral cavity, expectorated into a napkin, rinsed his mouth with tap water and announced his response. The subject was asked to guess if he did not produce an identification. He was asked: "Can you be more specific?" if he gave a category name (e.g., vegetable) rather than the name of a food substance.

At the conclusion of the final session of the experiment the subject completed the questionnaire, in the laboratory, which appears as appendix A.

## Results and Discussion

Analysis of variance showed the difference between the young and the elderly in the percentage of correct food identifications in the first session to be statistically significant at the .001 level ( $F=12.08$ ). The difference in identification ability continued even after feedback had been given. This difference during the third session was statistically significant at the .0001 level ( $F=33.84$ ). A sex effect ( $F=7.66$ ,  $p<.01$ ) and an age by sex interaction ( $F=8.85$ ,  $p<.005$ ) were also present for the data from the third session. Table 1 shows the mean percent correct for the various groups for the third session. Clearly, the elderly males experienced the most difficulty in identifying the foods after feedback. The results for the first and fifth sessions also appear in Table 1.

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Insert Table 1 About Here  
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The results for the individual food items established that the age of the subject did not affect the ability to identify some food items on the first exposure: both young and elderly subjects had approximately equal difficulty in identifying some of the items. Figure 1 shows the percentages of the young and old subjects who correctly identified each of the items on the first exposure.

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Insert Figure 1 About Here  
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After feedback, the young subjects showed a clear advantage over the elderly in identification for individual food items. Young subjects were significantly better than elderly subjects at identification of all items except beef, potato and celery. Since it is virtually impossible to completely eliminate texture cues for meat items, it is conceivable that texture provided information sufficient for identification of beef in the feedback sessions. Figure 2 shows the percentages of the young and elderly subjects who correctly identified each of the items on the third exposure, following one exposure with feedback as to the correctness of identification.

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Insert Figure 2 About Here  
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With extended practice all subjects improved their abilities to identify the twelve food items. By the fifth session the various groups of college students (males, females, smokers, non-smokers) averaged between 98% and 100% correct and the elderly who had never smoked averaged 94% correct. The elderly with a long history of cigarette smoking did not improve as much: females averaged 85% and males 70% correct.

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TABLE 1

	SESSION	YOUNG		ELDERLY	
		MALES	FEMALES	MALES	FEMALES
SMOKERS	1	62.5	57.33	29.56	42.33
	3	91.67	87.22	46.33	72.25
	5	98.67	99.11	70.00	85.00
NON-SMOKERS	1	65.8	60.80		45.22
	3	91.78	89.30		74.11
	5	100	98.40		94.33

Table 1 shows the mean percent correct for the various groups of subjects for sessions 1 (no feedback, first exposure), 3 (following one session with feedback), and 5 (following three sessions with feedback).

FIGURE 1

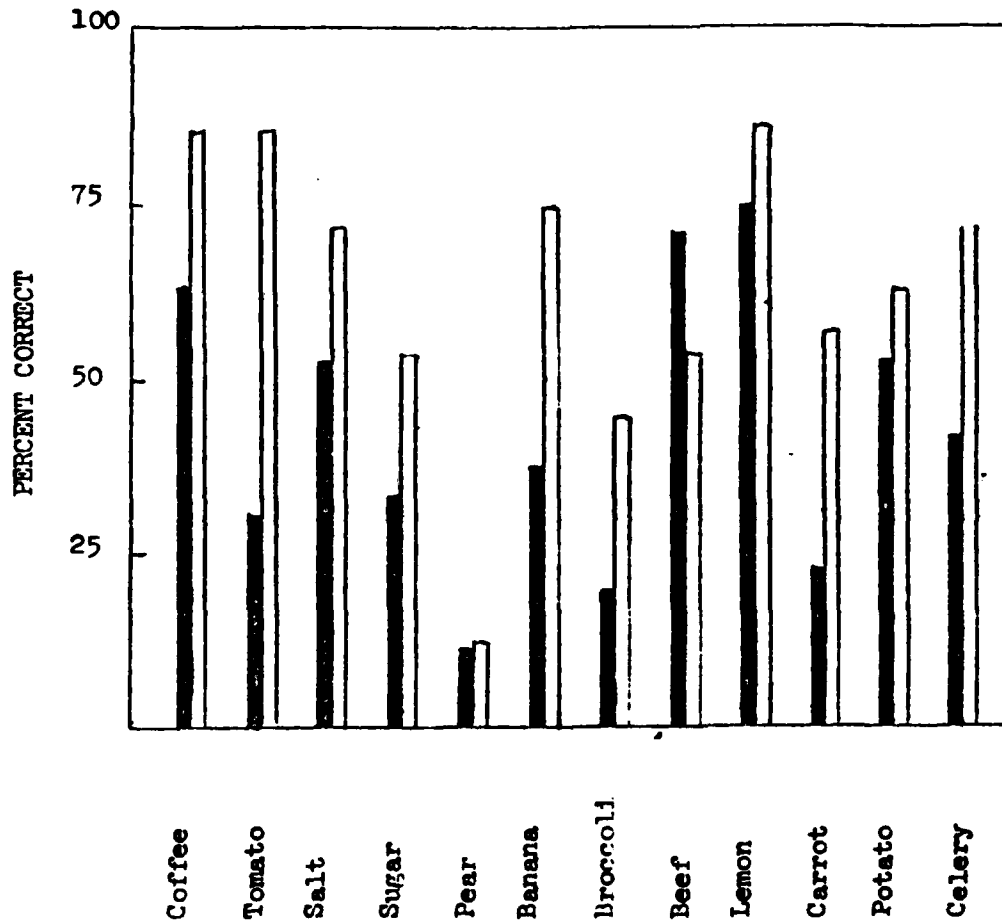


Figure 1 shows the percentages of the young and the elderly subjects who correctly identified each of the food items on the first exposure. Shaded bars represent data from the elderly; open bars represent data from young subjects.



FIGURE 2

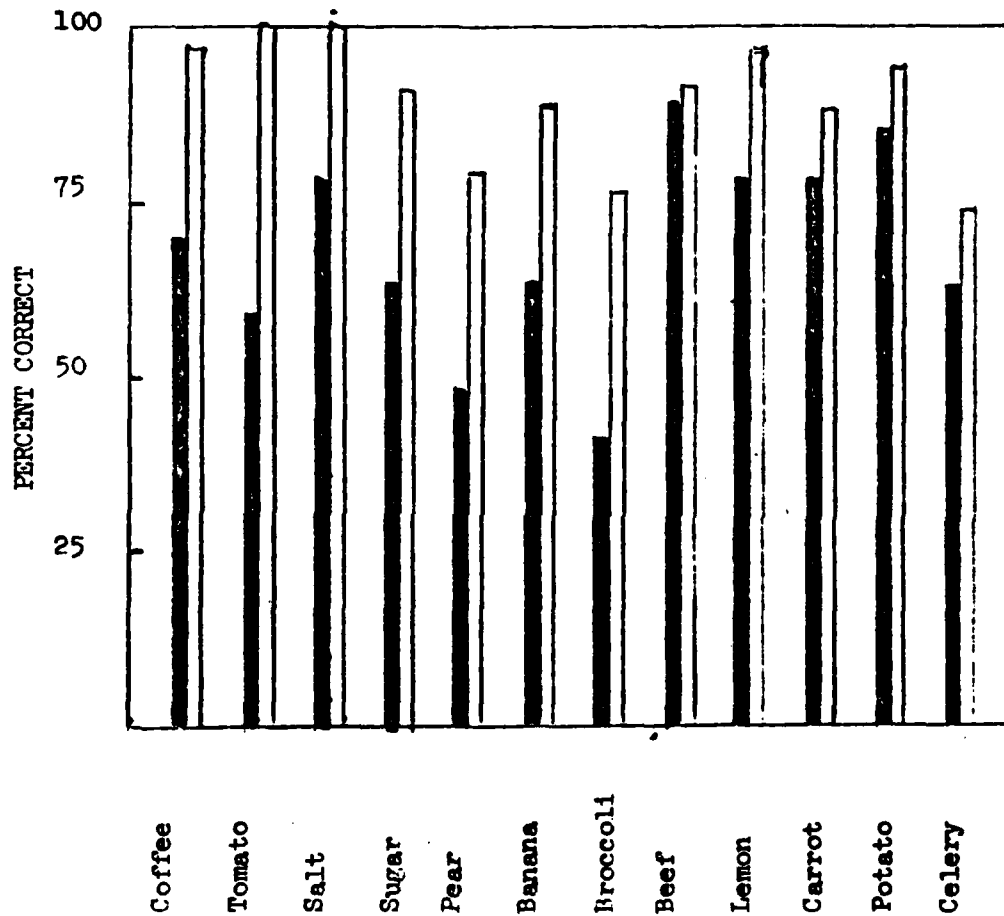


Figure 2 shows the percentages of the young subjects who correctly identified each food item after feedback (open bars), and of the elderly subjects who correctly identified each food item after feedback (shaded bars).

## Experiment 2

A second experiment probed further the age-related decline in ability to identify blended foods demonstrated by Schiffman (1977) and confirmed and further described in experiment 1. The only pure taste stimuli used by Schiffman were salt and sugar. The remaining stimuli were fruits, vegetables, meats, milk products, eggs, coffee, yeast and grains. Presumably these remaining stimuli contained some odor components while salt and sugar alone are non-odorous. The fact that these two stimuli were no better identified by the college students than by the elderly subjects in the study suggests that if there is a deficit in the chemical senses which mediates a decline in ability to identify blended foods, the decline may be largely olfactory.

Recent experiments have shown that significant olfactory input is referred to the taste system when the olfactory stimulus is presented in the mouth (Murphy, Bartoshuk and Cain, 1976; Murphy, Cain and Bartoshuk, 1977; Murphy and Cain, 1980). Pinching the nostrils closed both precludes olfactory stimulation and eliminates the referral phenomenon (Murphy and Cain, 1980). These results can be applied to the question of the nature of the decline in the ability to identify blended foods seen in elderly subjects. The foods used in the first experiment were presented to a second group of subjects whose nostrils were pinched closed, thereby insuring that the taste system, and not the olfactory system, was presented with stimulation. This constituted the major methodological difference between the first and the second experiments. The reasoning behind this manipulation was that if the ability of the college-age subjects to identify the foods fell to the same level as that of the elderly under these nose-closed conditions, the result would implicate the olfactory rather than the gustatory system as the source of the age-related decline.

## Method

Subjects were 13 young females and 8 elderly females recruited in the same manner and with the same health constraints described above for experiment 1.

Stimuli were identical to those used in experiment 1.

Procedure The procedure was identical to that in experiment 1 with one notable exception. Subjects were asked to identify the stimuli with the nostrils pinched closed. This operation effectively blocked olfaction.

## Results and Discussion

Data were analyzed using analyses of variance. The results of experiment 2 suggest that a decline in olfactory function produced the differences between the two age groups in the ability to identify foods in experiment 1.

There were no significant differences in the ability of young and elderly females to identify with the nostrils closed, the foods which had been presented in experiment 1. Since females alone were included in this experiment, the significant sex effect found in experiment 1 could be eliminated from the design. The analysis of variance performed on the percent correct on trial 1 showed the abilities of the two groups to be in the same range when operating, as they were in experiment 2, without the benefit of olfaction. In addition individual analyses on each of the twelve food items revealed no significant differences between the two groups, further supporting the above hypothesis.

When the results for the third session (the session which followed the first

instance of feedback on performance) were considered, differences between the two groups revealed themselves. The total percent correct for all items in session three was significantly higher ( $p < .01$ ) for young females (75%) than for elderly females (51%). These results are reflected in the significant differences ( $p < .05$ ) in the gain in performance in session three over session one for the young (32 percentage points) versus the elderly (18 percentage points). And also in the two significant differences in the ability to identify individual items in the third session: salt ( $p < .05$ ) and banana ( $p < .05$ ).

Since age effects on cognitive function have been clearly documented, the most plausible explanation for these results appears to be the following: A decline in olfactory function produces differences in the abilities of the young and elderly subjects to identify the blended foods as demonstrated in experiment 1. Blocking olfaction (as in experiment 2) reduces equally for both age groups sensory input from the olfactory system and therefore, information concerning the identity of foods. Hence performance is impaired at the same level for both groups under these conditions. However, elderly subjects have reduced cognitive functioning with particular deficits in the ability to store new information in memory. Hence, when presented with food stimuli without olfactory input and asked to associate food names with the sensory-deficient stimuli (and therefore, in real terms, novel stimuli), the elderly perform poorly with respect to the young subjects for whom the paired associate task is relatively easy.

These results and the above interpretation would suggest that Schiffman's original finding of reduced ability to identify foods in the elderly should be ascribed largely to an olfactory rather than a gustatory decline.

The elderly do appear to have a functional decline in olfaction which is accompanied by and possibly related to the decline in ability to perform on tests of olfactory threshold. Tests of ability to scale suprathreshold olfactory stimuli are imperative. The elderly do compensate for this decline in that they probably learn to associate food names with stimuli impoverished with respect to their former sensory impact. That this adjustment is made does not compensate for the lack of sensory enjoyment nor does it predict an adjustment in hedonic expectation in the elderly. To the extent that food intake is linked to hedonic tone, reduced intake should be expected in the elderly population.

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APPENDIX A

Name \_\_\_\_\_

Address \_\_\_\_\_

Telephone \_\_\_\_\_

Date of Birth \_\_\_\_\_

Height \_\_\_\_\_

Weight \_\_\_\_\_

Age \_\_\_\_\_

Smoking history: never \_\_\_\_\_ formerly \_\_\_\_\_ currently \_\_\_\_\_; for how long? \_\_\_\_\_

Packs per day: formerly \_\_\_\_\_ currently \_\_\_\_\_ Time since last cigarette \_\_\_\_\_

Do you cook for yourself regularly? \_\_\_\_\_ for others as well? \_\_\_\_\_

Do you have any problems with or complaints about taste? If so, what are they?  
How long have you had them? \_\_\_\_\_

Do things taste more intense, less intense (strong), or about the same as they have  
all your life? \_\_\_\_\_

Have your preferences in food flavors changed? If so, How? \_\_\_\_\_

Have your preferences in foods changed? \_\_\_\_\_ If so, which foods do you now  
prefer, find less appealing, or avoid? Why? \_\_\_\_\_

Have you increased or decreased your use of condiments (e.g. salt, sugar)? If so,  
which one(s) and why? \_\_\_\_\_

Do you wear partial \_\_\_\_\_ or full \_\_\_\_\_ dentures? \_\_\_\_\_

How many alcoholic drinks do you usually consume per day? \_\_\_\_\_ per week? \_\_\_\_\_

Please rate how well you like the following foods:

banana	dislike extremely	_____	like extremely
pear	"	_____	"
lemon	"	_____	"
broccoli	"	_____	"
celery	"	_____	"
tomato	"	_____	"
potato	"	_____	"
carrot	"	_____	"
beef	"	_____	"
coffee	"	_____	"
salt	"	_____	"
sugar	"	_____	"

Please rate how often you eat the following foods:

banana	never	_____	several times daily
pear		_____	
lemon		_____	
broccoli		_____	
celery		_____	
tomato		_____	
potato		_____	
carrot		_____	
beef		_____	
coffee		_____	
salt		_____	
sugar		_____	

Thank you for participating in the experiment!

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